said electrode is selected from the group consisting of a titanium nitride film, a zirconium nitride film, a hafnium nitride film, a tantalum nitride film and a niobium nitride film.

REMARKS

In this Amendment, Applicants have amended claims 12 and 16 – 18 to more appropriately define the present invention. In accordance with the requirements of 37 C.F.R. § 1.121(c)(1), Applicants provide a marked-up version of the amendments to the claims in an attached Appendix designated "Version of Claims with Markings to Show Changes Made." Claims 1 – 20 remain pending, with claims 1 – 11, 19, and 20 withdrawn from consideration.

On March 11, 2002, Applicants received a "Decision on Petition to Reset Period for Reply," dated March 5, 2002. The Decision granted Applicants' Petition, and reset the time period for response to the October 19, 2001 Office Action to run from the receipt date of January 14, 2002. Since the October 19th Office Action was marked as received by Applicants' representatives on January 14, 2002, the new due date for a response to the Office Action should be three months from this date of receipt, April 14, 2002, thus obviating the need to file a Petition for Extension of Time of Two Months concurrent with this Amendment. See M.P.E.P. § 710.06, 8th Ed., Aug. 2001, p. 700-130. Applicants request the Examiner's written confirmation of this conclusion.

In the Office Action, the Examiner rejected claim 16 under 35 U.S.C. § 112, second paragraph as indefinite; rejected claims 12 – 16 under 35 U.S.C. § 103(a) as unpatentable over Hu, et al. (U.S. Patent No. 5,962,904) in view of Wittmer, et al., Oxidation Kinetics of TiN Thin Films, J. Appl. Phys. 52(11), pp. 6659 – 6664 (1981); and rejected claims 17 and 18 under 35 U.S.C. § 103(a) as unpatentable over Hu in view of Wittmer as applied to claims 12 – 16, and further in view of Nakajima, et al. (U.S. Patent No. 5,907,188).

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Regarding the rejection of claim 16 under 35 U.S.C. § 112, 2nd paragraph, Applicants have amended claim 12 to recite "said metal-containing insulating film includes at least one surface which is covered with a covering insulating region made of the amorphous insulating material," thereby addressing the Examiner's statement that the claim was indefinite (Office Action, p. 2). Claim 16 complies with the requirements of 35 U.S.C. § 112, 2nd paragraph, and Applicants accordingly request withdrawal of that rejection.

Regarding the 35 U.S.C. § 103(a) rejection of claims 12 – 16, Applicants disagree with the Examiner's arguments and conclusions. The Examiner does not show that all the elements of Applicants' claims are met in the cited references, and does not show that there is any suggestion or motivation to modify the cited references to result in the claimed invention. "To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. ... If an independent claim is nonobvious under 35 U.S.C. § 103, then any claim depending therefrom is nonobvious." See M.P.E.P. § 2143.03, 8th Ed., Aug. 2001, p. 2100-26. Furthermore, regarding dependent claims 13 – 16, "Examiners are reminded that a dependent claim is directed to a combination including everything recited in the base claim and what is recited in the dependent claim. It is this combination that must be compared with the prior art, exactly as if it were presented as one independent claim." M.P.E.P. § 608.01(n)(III), p. 600-77.

Applicants' claims 12 recites a combination of elements, including, *inter alia*, "a metal-containing insulating film formed directly or indirectly on said semiconductor substrate, said metal-containing insulating film including a plurality of first insulating regions each of which is formed of a grain containing a metal oxide and a second insulating region formed between the first insulating regions and occupied by an amorphous insulating material."

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Hu and/or Wittmer do not teach or suggest at least these recitations of Applicants' claim 12. In contrast, Hu discloses a 9 nm gate oxide layer 14, poly-Si layer 16, electrically conductive Si material (preferably refractory metal Si-nitride and also amorphous (Hu, col. 5, ll. 59-60)) as a diffusion barrier 18, a W / W_xSi_y electrode layer 20, and a cap 34. While the Examiner acknowledges that "Hu does not specifically describe its insulating films as being formed of metal oxide" (Office Action, p. 3), Hu also does not teach or suggest at the least the recitations of Applicants' claim 12 as discussed above. Hu clearly does not disclose a "metal-containing insulating film including a plurality of first insulating regions each of which is formed of a grain containing a metal oxide and a second insulating region formed between the first insulating regions and occupied by an amorphous insulating material" (Applicants' claim 12), because Hu's only insulating film is gate oxide layer 14 (Figure 4). Hu's remaining film layers are either semiconducting (poly-Si layer 16) or electrically conductive (diffusion barrier 18 and W / W_xSi_y electrode layer 20). Hu obviously does not teach or suggest a plurality of first insulating regions.

While the Examiner alleges "it would have been obvious to one of ordinary skill in the art at the time of the invention to use the material specified by Wittmer[,] namely TiO2[,] as the insulative layer instead of the well known SiO2" (Office Action, p. 4), Wittmer still does not cure the deficiencies of Hu. Wittmer's "investigat[ion of] the oxidation kinetics of TiN thin films dry O_2 in view of possible application of TiN as the material for gate electrodes" (Wittmer, Abstract) still does not teach or suggest the recitations of Applicants' invention not taught or suggested by Hu. Since Hu and/or Wittmer, taken alone or in combination, do not teach or suggest at least the elements of Applicants' claim 12, the Examiner's application of Hu and Wittmer as references to formulate an obviousness rejection under 35 U.S.C. § 103(a) is improper.

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The Examiner has therefore not met at least one of the essential criteria for establishing a *prima facie* case of obviousness, wherein "the prior art reference (or references when combined) must teach or suggest all the claim limitations." See M.P.E.P. §§ 2142, 2143, and 2143.03.

Furthermore, there is no suggestion or motivation to modify Hu with Wittmer to produce Applicants' claimed invention. Even if the Examiner's characterization of Hu (see Office Action, p. 3) were correct (which Applicant disputes), this still does not establish that there would have been the requisite suggestion or motivation to modify Hu with Wittmer. "The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." M.P.E.P. § 2143.01, p. 2100-124, citing *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). Even modifying Hu to "use the material specified by Wittmer" (Office Action, p. 4), as the Examiner suggests, would still not produce Applicants' present invention. Because Hu and Wittmer *cannot* be modified to produce Applicants' invention, their resultant combination cannot be obvious as it does not produce Applicants' claimed invention. Likewise, there cannot be any expectation of success from so doing, because combining the references still would not produce Applicants' claimed invention.

Furthermore, the M.P.E.P. states "[a] statement [by the Examiner] that modifications of the prior art to meet the claimed invention would have been "'well within the ordinary skill of the art at the time the invention was made'" because the references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references." M.P.E.P. § 2143.01, p. 2100-124 (citations omitted, emphasis in original). Because Applicants have already established that Hu and Wittmer cannot be modified to produce the

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present invention, Applicants submit that, according to the M.P.E.P., the Examiner's citation of Hu and Wittmer is not sufficient to establish *prima facie* obviousness over Applicant's claims 12 – 16.

Regarding the 35 U.S.C. § 103(a) rejection of claims 17 and 18, Applicants disagree with the Examiner's arguments and conclusions, for the reasons already discussed above pertaining to the rejection of claims 12 – 16.

Specifically, the Examiner acknowledges that "Hu and Wittmer do not specifically describe the decrease of the Gibbs free energy at the time when a metal constituting the gate electrode forms an oxide layer ..." (Office Action, p. 5). In addition, Applicants have already established that Hu's only insulating film is gate oxide layer 14 (Figure 4), and therefore Hu also cannot teach or suggest "a first metal oxide insulating film formed directly or indirectly on a semiconductor substrate; a second metal oxide insulating film formed on said first metal oxide insulating film" (Applicants' claim 17). Furthermore, since Wittmer is only directed to the study of "the oxidation kinetics of TiN thin films dry O_2 in view of possible application of TiN as the material for gate electrodes" (Wittmer, Abstract), as already discussed, Wittmer cannot cure the deficiencies of Hu.

The Examiner then cited Nakajima, col. 11, ll. 14 – 24, to describe "the decrease of the Gibbs free energy at the time when a metal constituting the gate electrode forms an oxide layer is larger than that at the time when a metal constituting the first metal oxide film forms an oxide" (Office Action, p. 5). Applicants submit that the Examiner has mischaracterized Nakajima. Nakajima instead discloses "[a]n amount of drop in the [Gibbs] free energy caused when tungsten nitride is formed from tungsten is smaller than that caused when silicon nitride is formed from silicon" (Nakajima, col. 11, ll. 14 – 16). Nakajima teaches that the chemical

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potential is lower between a WN_x film and a Si substrate, which merely demonstrates the diffusion direction of N, and N segregation at a W/Si interface. See Nakajima, col. 11, ll. 17 – 24. Nakajima does not teach or suggest "the decrease of the Gibbs free energy at the time when a metal contained in the second metal oxide insulating film forms an oxide is larger than or equal to that at the time when the metal contained in the electrode forms an oxide" (Applicants' claim 17). Therefore, the Examiner's allegation that "it would have been obvious to one of ordinary skill in the art at the time of the invention to include [Nakajima's] specific Gibbs free energy parameters in Hu's and Wittmer's device..." (Office Action, p. 6) is unsupported, since (a) Wittmer does not disclose a "device", and (b) Nakajima's "specific Gibbs free energy parameters" are only directed to N segregation and not to Applicants' claimed invention. Applicants have already established that Hu and Wittmer cannot properly be modified to produce the present invention, and now submit that Hu, Wittmer, and Nakajima, taken alone or in combination, similarly, cannot be modified to produce the present invention. Applicants submit that, according to the M.P.E.P., alread cited above, the Examiner's citation of Hu, Wittmer, and Nakajima is not sufficient to establish *prima facie* obviousness over Applicants' claims 17 and 18.

Applicants have demonstrated herein that the Examiner: (a) has not shown all recitations of Applicants' claimed invention are taught or suggested by Hu and/or Wittmer, or by Hu, Wittmer and/or Nakajima; (b) has not shown any requisite motivation to modify Hu with Wittmer, or Hu and Wittmer with Nakajima; and (c) has not shown there would be any reasonable expectation of success from modifying Hu with Wittmer, or Hu and Wittmer with Nakajima, in order to produce Applicants' claimed invention.

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In view of the foregoing, Applicants submit that the rejection of claims 12 – 18 is improper and should be withdrawn. Applicants submit that independent claims 12 and 17 are in condition for allowance as are claims 13 – 16 and 18, at least by virtue of their dependence from allowable base claims 12 and 17. A favorable action is requested.

If any extension of time is required under 37 C.F.R. § 1.136 to obtain entry of this response, and not requested by attachment, such extension is hereby requested. If there are any fees due under 37 C.F.R. § 1.16 or 1.17 that are not enclosed, including any fees required for an extension of time under 37 C.F.R. § 1.136, please charge those fees to our Deposit Account No. 06-0916.

Respectfully submitted,

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Dated: March 19, 2002

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APPENDIX TO AMENDMENT OF March 19, 2002

Version of Claims with Markings to Show Changes Made

AMENDMENTS TO THE CLAIMS:

Please amend claims 12 and 16 – 18 as follows:

12. (Amended) A semiconductor device, comprising:

a semiconductor substrate;

a metal-containing insulating film formed directly or indirectly on said semiconductor substrate, said metal-containing insulating film [consisting of] including a plurality of first insulating regions each of which is formed of [grains] a grain containing a metal oxide and a second insulating region formed [of] between the first insulating regions and occupied by an amorphous insulating material [in a region except the first insulating regions]; and

an electrode formed on said metal-containing insulating film.

16. (Amended) The semiconductor device according to claim 12, wherein said metal-containing insulating film [further comprises a covering insulating region covering] includes at least one surface which is covered with a covering insulating region made of the amorphous insulating material [of a main insulating region consisting of said first insulating regions and said second insulating region and formed of an amorphous insulating material equal to that constituting said second insulating region].

17. (Amended) A semiconductor device, comprising:

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a first metal oxide insulating film formed directly or indirectly on a semiconductor substrate;

a second metal oxide insulating film formed on said first metal oxide insulating film; and

[a gate] an electrode formed on said second metal oxide insulating film,

wherein, the decrease of the Gibbs free energy at the time when a metal [constituting] contained in the [gate] electrode forms an oxide is larger than that at the time when a metal [constituting] contained in the first metal oxide insulating film forms an oxide, and the decrease of the Gibbs free energy at the time when a metal [constituting] contained in the second metal oxide insulating film forms an oxide is larger than or equal to that at the time when the metal [constituting] contained in the [gate] electrode forms an oxide.

18. (Amended) The semiconductor device according to claim 17, wherein said second metal oxide insulating film is selected from the group consisting of a titanium oxide film, a zirconium oxide film, a hafnium oxide film, a tantalum oxide film and a niobium oxide film, and said [gate] electrode is selected from the group consisting of a titanium nitride film, a zirconium nitride film, a hafnium nitride film, a tantalum nitride film and a niobium nitride film.

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